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OVERBURDEN ANALYSES AND STRIP-MINE CONDITIONS IN NORTHEASTERN OHIO

BY
G. A. LIMSTROM

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 **CENTRAL STATES
FOREST EXPERIMENT STATION**
Columbus 13, Ohio

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STRIP-MINING DISTRICTS

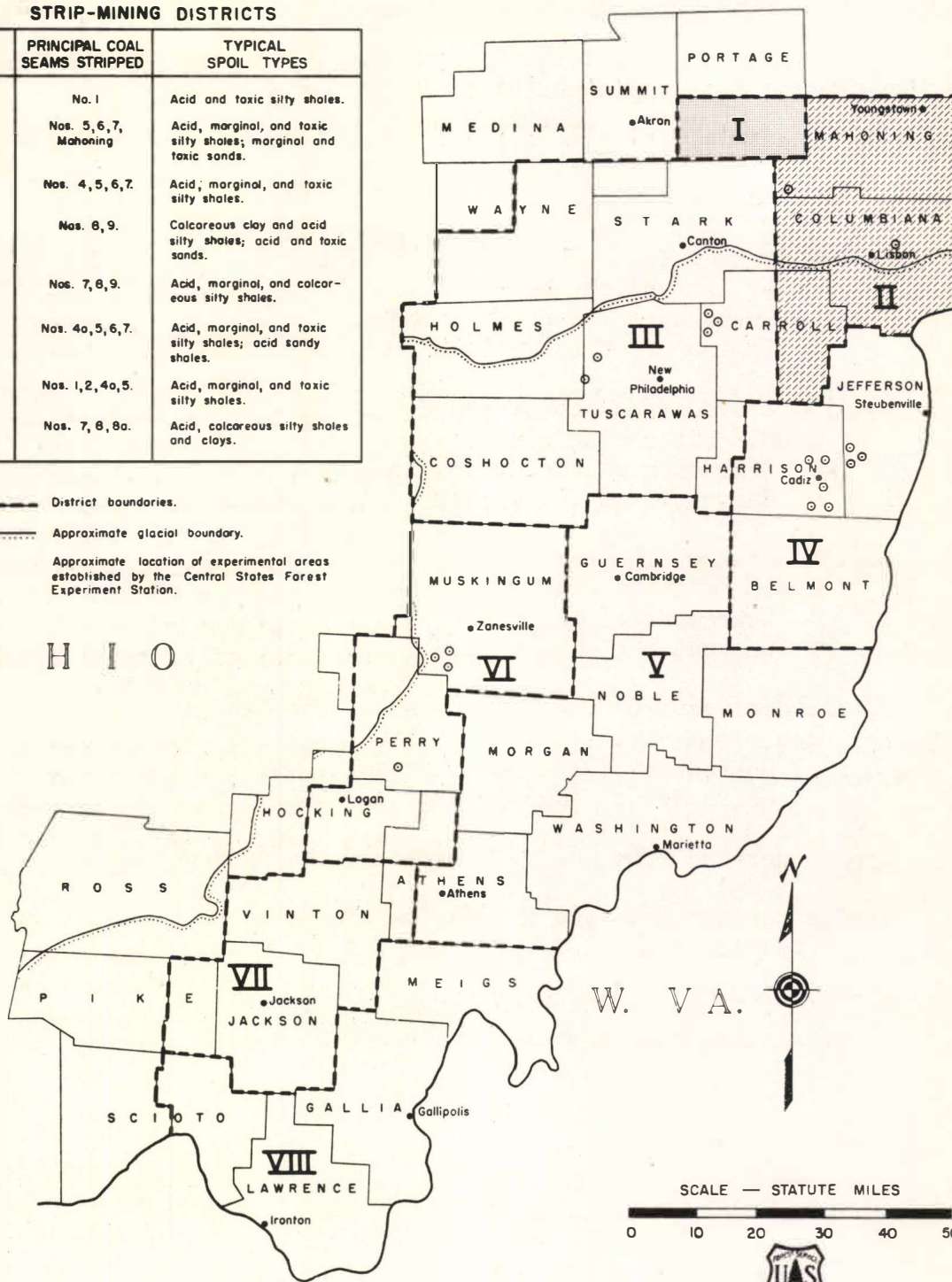
DIST. NO.	PRINCIPAL COAL SEAMS STRIPPED	TYPICAL SPOIL TYPES
I	No. 1	Acid and toxic silty shales.
II	Nos. 5, 6, 7, Mahoning	Acid, marginal, and toxic silty shales; marginal and toxic sands.
III	Nos. 4, 5, 6, 7	Acid, marginal, and toxic silty shales.
IV	Nos. 8, 9.	Calcareous clay and acid silty shales; acid and toxic sands.
V	Nos. 7, 8, 9.	Acid, marginal, and calcareous silty shales.
VI	Nos. 4a, 5, 6, 7.	Acid, marginal, and toxic silty shales; acid sandy shales.
VII	Nos. 1, 2, 4a, 5.	Acid, marginal, and toxic silty shales.
VIII	Nos. 7, 8, 9a.	Acid, calcareous silty shales and clays.

--- District boundaries.

- - - - - Approximate glacial boundary.

○ Approximate location of experimental areas established by the Central States Forest Experiment Station.

O H I O



Frontispiece—The coal-mining region of Ohio. Stippling indicates the location of strip-mining District No. I; diagonal dashes indicate the location of District No. II.

OVERBURDEN ANALYSES AND STRIP-MINE CONDITIONS IN NORTHEASTERN OHIO

(Strip-mining Districts No. I and No. II. Southern Portage
County; Columbiana and Mahoning Counties and eastern
Carroll County)

by

G. A. Limstrom

INTRODUCTION

Conditions affecting reclamation measures for strip-mined lands in Ohio vary considerably with the coal seam removed and locality. Each area requires a distinctive treatment, and the practitioner needs detailed information to aid him in the proper choice of possible uses for these lands. A basic classification of spoils of general application in the Central States Region, together with detailed forest planting recommendations on strip-mined lands in Ohio, has already been published.^{1/} A description of site conditions on specific areas may prove helpful in developing planting plans and may serve as an index of probable site conditions on future strippings for a given locality and coal seam.

The coal-mining region of Ohio has been subdivided into eight strip-mining districts (frontispiece). Although there is some overlapping of characteristics, spoil conditions in each district are sufficiently distinctive to make the district a convenient unit for detailed descriptions of strip-mine reclamation problems in the state. A reconnaissance of lands stripped for coal was made from 1945 to 1947. Each area was examined to determine spoil texture, acidity, and other conditions affecting plant growth. A record of these conditions was made, and a map of the area was prepared. In addition, the "high-walls" adjacent to most strippings were carefully examined and described stratigraphically. Samples of spoil surfaces and of each stratum found in the high-walls were collected for laboratory analyses.

^{1/} G. A. Limstrom. Extent, Character, and Forestation Possibilities of Land Stripped for Coal in the Central States. Central States Forest Experiment Station, Technical Paper No. 109. Mult. 79 pp. December 1948.

----- and R. W. Merz. The Rehabilitation of Lands Stripped for Coal in Ohio. Central States Forest Experiment Station, Technical Paper No. 113. December 1949.

The main purpose of this report is to present these reconnaissance data in summary form for Strip-Mining District No. I, southern Portage County, and for District No. II which includes Columbiana and Mahoning Counties and the eastern half of Carroll County. Another purpose is to contribute to the general knowledge of Ohio geology by making a permanent record of the stratigraphic data.

STRIP-MINING DISTRICT NO. I (Southern Portage County)

In July 1946 there were only 186 acres of strip-mined land in Portage County. All of the stripping was located in Atwater and Deerfield Townships, and the coal removed was the No. 1, Sharon--at times known locally as the Massillon coal.

The spoils in the county are loamy in texture and have a high proportion of silty shale and fragmental sandstone. Where glacial till has been placed on the surface in the mining process, there are occasional patches of clay and sandy clay spoils. Except for small acid areas most of the banks are toxic and not plantable. Toxicity is due mainly to the fact that the gray and black carbonaceous shale directly overlying the coal seam has been placed on top of the spoils. Chemical analyses of the shale over the coal in this vicinity reveal very toxic conditions. One sample indicated a pH value as low as 2.7 (tables 2 and 3 in the Appendix). The overburden of the No. 1 coal in southern Portage County is composed mainly of glacial till and a mixture of sandstone and silty shale of good fertility and of favorable acidity. Toxic materials occur only in a zone within 8 feet of the coal seam.

In order to avoid tree planting on areas that are toxic a preplanting survey should be made to delineate the nonplantable areas. They should be marked by staking, or, if easily identifiable, the planting foreman and crew should be instructed not to plant them.

Nontoxic spoils in the county are ideally suited to the growing of all hardwoods native to the county. Mixtures of these species that include black locust are recommended. Red and chestnut oaks, for example, do well on all exposures, while such species as hard maple, white ash, white oak, linden, and black walnut do well only on the lower halves of the ridges. These spoils are also suitable for growing cottonwood, silver maple, and sycamore for pulpwood, posts, and props.

Strip-mined lands in the county are ideally suited to such coniferous species as white, red, jack, and Scotch pines for the production of Christmas trees, pulpwood, and lumber.

STRIP-MINING DISTRICT NO. II (Columbiana, Mahoning and eastern Carroll Counties)

The reconnaissance of strip-mined lands in Columbiana County was made in June 1946, in Mahoning County in July 1946, and in eastern Carroll

County in September 1946. At that time there was an estimated area of 4,390 acres of spoil surfaces resulting from the mining of coal in this district (table 1). The spoils on more than one-half of this area were loamy with a high proportion of silty shale. There is also a relatively large area of sandy spoils, but only a small proportion composed mainly of clay. Of the total area of strip-mined land in the district, 197 acres or 4.8 percent was found to be toxic and therefore not plantable. The greatest concentration of toxic areas was found in Mahoning County, where an estimated 23.5 percent of the spoil area was toxic. Most of the banks in these counties were moderately acid in character, but were generally ideal for tree growth. Where glacial till had been placed on the tops of banks they were sometimes calcareous.

All of Mahoning County and the northern half of Columbiana County are located in the glaciated region of Ohio (frontispiece). Spoils on level to gently rolling terrain in the glaciated areas may have a considerable proportion of soil-size particles derived from glacial till, some of which may be calcareous. Where these conditions exist, strip-mined lands make ideal sites for tree growth and offer good agricultural possibilities as well. Because the mantle of glacial detritus is very thin or absent, spoils in this part of the district that are located on steep hillsides and ridges are much like those found outside the glaciated area.

In Columbiana County the No. 7, Upper Freeport coal is sometimes called No. 6. Some people know the Mahoning seam as No. 7, while others know it as the "Groff" or the "Salineville Strip" coal. ^{2/}

The elevation of coal seams in Columbiana County varies considerably, even within a restricted locality. This makes it difficult to identify coal seams by elevation alone. For example, the No. 7, Upper Freeport seam near West Point in Section 9, Madison Township is 40 to 50 feet below its elevation in Section 31, Elk Run Township, only about 3 miles distant.

SPOILS DERIVED FROM THE OVERBURDEN OF THE NO. 5, LOWER KITTANNING COAL

Most of the stripping operations for this coal in the district was found in Mahoning County. Only one extensive spoil area resulting from mining the No. 5 coal was found in Columbiana County. This area is located near Negley in Section 13, Middleton Township where the seam is thin and mined coincidentally with stripping for clay.

Character of the Overburden

The stratum immediately over the No. 5 coal seam in this district is generally a purplish, thin-bedded, soft, silty shale containing a

^{2/} Wilbur Stout, and R. E. Lamborn, Geology of Columbiana County, Fourth Series, Bulletin 28, Geological Survey of Ohio, 1924.

Table 1.--Area of strip-mined land in District No. II, Ohio, by county and by soil texture
and acidity classes, 1946

County and coal seam	Sands						Loams and silty shales						Clays				Total
	Acidity class																
	Toxic	Marginal	Acid	Calcareous	Mixed	Toxic	Marginal	Acid	Calcareous	Mixed	Toxic	Marginal	Acid	Calcareous	Mixed		
----- Acres -----																	
Columbiana																	
No. 5	-	-	-	-	-	-	3	113	-	-	-	-	-	-	-	116	
Lower Freeport	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	6	
No. 7	46	204	938	-	-	-	230	1,366	-	-	-	-	71	-	-	2,855	
Mahoning	-	-	263	-	-	-	-	248	21	-	-	-	-	-	-	532	
Total	46	204	1,201	-	-	6	233	1,727	21	-	-	-	71	-	-	3,509	
Carroll (eastern half)																	
Harlem	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	5	
Mahoning	-	-	57	-	-	-	-	204	-	-	-	-	-	-	-	261	
Total	-	-	57	-	-	-	-	204	-	5	-	-	-	-	-	266	
Mahoning																	
No. 5	18	-	-	2	-	-	-	-	90	-	-	-	43	-	-	153	
No. 6	127	12	9	-	75	-	-	-	-	-	-	41	-	-	-	264	
No. 7	-	-	198	-	-	-	-	-	-	-	-	-	-	-	-	198	
Total	145	12	207	2	75	-	-	-	90	-	-	41	43	-	-	615	
All counties and coal seams	191	216	1,465	2	75	6	233	1,931	111	5	-	41	114	-	-	4,390	

variable amount of red kidney ores, pyrites, and iron concretions. These rocks often contain a considerable amount of toxic material. Immediately over the coal a narrow band of fossiliferous shale, known as the Hamden formation, sometimes occurs. This often contains nodular limestone.

Over the shale may be found glacial till and soil, both of variable thicknesses. The shales and glacial material often contain high proportions of available phosphorus, but appear to be low in potash (tables 4, 5, 6).

Character of the Spoils

The condition of spoils derived from the mining of the No. 5, Lower Kittanning coal in the district varies considerably according to the methods of mining. In Columbiana County these spoils are mainly acid, silty shales. In Mahoning County some are toxic sands, some are calcareous loams, and others are marginal or acid clays. Glacial till is often calcareous; when this material has been placed on top of the spoils, their surfaces are also calcareous. In these counties nearly all strip-mined lands that result from mining the No. 5 coal have a high proportion of soil, and the ridges are low and gently rolling. Because of these conditions, sufficient moisture is generally available for good plant growth, and those areas which are also calcareous have some agricultural possibilities.

A careful examination of each bank should be made before or during tree-planting operations in order to exclude toxic areas from the planting sites. The acid, silty shales are best suited to such conifers as red, jack, and white pine, and to such acid-tolerant hardwoods as black locust, sycamore, and cottonwood. Because the pH range of the acid spoils resulting from the mining of the No. 5 coal in the district is generally from 4.0 to 5.5, the advisability of planting such hardwoods as yellow poplar, white ash, and black walnut on these highly acid sites is still questionable.

The calcareous spoils resulting from the mining of No. 5 coal in the district are no doubt of some agricultural value but are also excellent sites for yellow poplar, white and green ash, cottonwood, sycamore, red cedar, and perhaps for hard maple and linden.

SPOILS DERIVED FROM THE OVERBURDEN OF THE NO. 6, MIDDLE KITTANNING COAL

During the course of the reconnaissance no stripping of the No. 6 coal seam was found in Columbiana and eastern Carroll Counties. In Mahoning County a number of small strippings for this coal were found, totalling 269 acres. Spoil surfaces resulting from the mining of the No. 6 coal in Mahoning County are generally sandy and toxic. Toxicity of the surfaces is due mainly to the usual practice of placing on top of the spoil banks the material from toxic strata found directly over the coal seam.

Character of the Overburden

Over the main minable seam of the No. 6 coal there is sometimes found a thinner, "rider vein" of coal. The material between these two seams is usually an acid, gray-black, clayey shale. Over these seams of coal is found a soft, thin-bedded, ferruginous shale 2 to 6 feet thick, often with a large quantity of red kidney ores. Most of the toxicity of the spoils stems from this stratum. Above this shale there is usually a thick bed of massive sandstone of variable acidity, changing in some locations to thin-bedded, fragmental sandstone or sandy shale. Over the sandstone is the glacial till, varying considerably in thickness, and composed mainly of sedimentary and igneous material. The glacial till is generally composed of sands or sandy clays. The glacial material and sandstone often contain a medium to high amount of available phosphorus. All strata overlying the No. 6 coal seam in Mahoning County appear to be low in available potassium (tables 7, 8, 9, and 10).

Character of the Spoils

Except for small areas where glacial material has been placed on the tops of banks, most of the spoils resulting from the mining of the No. 6 coal in Mahoning County are toxic. The spoils are generally sands or sandy clays.

Because of toxic conditions most of the No. 6 coal strippings in Mahoning County are considered nonplantable at the present time. Careful acidity determinations should be made before planting is considered. Where spoils are not highly acid they can be planted to northern conifers and the hardwoods native to the locality.

SPOILS DERIVED FROM THE OVERBURDEN OF THE NO. 7, UPPER FREEPORT COAL

More than 2,800 acres of strip-mined land resulting from the mining of No. 7 coal were mapped in Columbiana County. Only about 200 acres were found in Mahoning County (table 3). No stripping for this coal was found in eastern Carroll County. Stripping of this seam represents about 80 percent of the total stripping in Columbiana County and approximately 30 percent in Mahoning County.

Character of the Overburden

Directly over the No. 7 coal is a layer of thin-bedded shale varying in thickness from 4 to 24 feet. In the lower portion it is blue-gray to black in color, acidic, slaty, carbonaceous, and hard. In the upper portion of this stratum the shale is gray-green to gray-blue in color with some red mottling, acidic, silty, and very hard. Over the shale is sometimes found a very hard, gray to gray-brown massive sandstone. Although the sandstone is usually acidic, the surfaces of these stones may sometimes be calcareous. Over the shale--and massive sandstone, if

present--is a layer of fragmental sandstone consisting of a mixture of small stones and sand. Glacial till, if present, is located in the upper portion of the overburden. It consists of sand, silt, clay, or a mixture of these materials--often with well-rounded igneous rocks and with sandstone and limestone blocks up to 4 or 5 cubic feet in volume. In shallow cuts, the massive sandstone and other sandy material may be absent. Strippings in valley-bottoms, such as those found in Section 11, Wayne Township, Columbiana County, may consist entirely of sandy or silty alluvial soils.

Most of the strata over the No. 7 coal seam appear to be high in available phosphorus but low in potassium (tables 11 to 28).

Character of the Spoils

Most of the No. 7 spoils are sandy in character or consist of loamy, silty shales. Acidity is generally in the pH range of 5.0 to 7.0 and favorable for tree growth. Only a few toxic areas exist. The spoils vary considerably in the proportion of soil to stone. Because most of the shales are hard and bony those banks having a low percentage of soil may remain in that condition for many years. On those banks having a high proportion of sandy surface material, weathering will no doubt progress at a faster rate than on those composed mainly of hard shales.

SPOILS DERIVED FROM THE OVERBURDEN OF THE MAHONING COAL SEAM

In 1946 the total area of stripped land in the district resulting from the mining of the Mahoning coal was estimated at 793 acres. Of this area, 261 acres occurred in eastern Carroll County and 532 acres in Columbiana County. No stripping for this seam was found in Mahoning County.

Character of the Overburden

The Mahoning coal lies about 40 feet above the No. 7, Upper Freeport. The strata overlying both seams are quite similar in composition, except that there is usually some massive sandstone over the No. 7 coal. Where sandy material appears over the Mahoning coal it is usually in the form of single-grain sand or of loose, fragmental, sandy shale. The Mahoning coal overburden consists mainly of shales which are silty, hard, blue-gray in color, and thin-bedded. The lower portions of the shale are usually blue-gray to black in color, carbonaceous and slaty, sometimes with red mottling. If the overburden is thick--more than 25 feet--the upper portion of the shale becomes sandier, gray, and thick-bedded, resembling sandstone. The glacial till, if present, is near the surface, generally less than 2 feet in thickness, and of variable composition.

Character of the Spoils

The spoils resulting from the stripping of the Mahoning coal are most often sandy or loamy with a considerable amount of hard, bony shale. The pH range is from 4.0 to 6.9. No toxic areas were found on these spoils at the time of reconnaissance. An outstanding characteristic of the Mahoning spoils is the relatively low proportion of soil and high proportion of hard, slow-weathering shales. One area north of Negley in Middleton Township, Columbiana County, that was stripped for Mahoning coal 12 years prior to the reconnaissance was found to be composed of less than 25 percent soil. Banks of this textural composition are most suitable for dry-site species, such as the pines, chestnut and red oaks, and black locust.

SPOILS DERIVED FROM THE OVERBURDEN OF THE HARLEM COAL

The Harlem coal occurs rather sparingly--only in a few localities in Carroll County. One small area stripped for this coal was found in Lee Township. The spoils of this area were composed of 45 percent soil, 50 percent shale, and 5 percent massive limestone. Only a partial description of the high-wall was obtainable, as follows:

			<u>Thickness</u>
			<u>Feet</u>
Soil	: gray silty clay loam, acidic		0.5
Shale	: gray, thin-bedded, acidic		6+
Talus			10
Coal	: (Duquesne ?) shaly		1
Shale	: clayey, granular, acidic		2+
Talus			8
Limestone	: massive (Ames ?)		2+

SPOILS DERIVED FROM THE OVERBURDEN OF LOWER FREEPORT COAL

Only one stripped area, 6 acres in extent, was believed to be the result of mining the Lower Freeport, or Rogers, coal. This was located in Section 30, Center Township, Columbiana County. The spoils, located in a stream bottom, were mainly composed of highly acid carbonaceous shale and some alluvium. No high-wall was found from which a stratigraphic record could have been obtained.

The tables on the following pages give the descriptions and chemical analyses of strata over the important coal seams strip-mined in northeastern Ohio. The index below lists the tables for each coal seam by county, township, and section.

<u>Coal seam</u>	<u>County</u>	<u>Township</u>	<u>Section</u>	<u>Table No.</u>
No. 1	Portage	Atwater	—	2
		Deerfield	—	3
No. 5	Columbiana	Middleton	13	4
		Salem	17	5
No. 6	Mahoning	Beaver	12	6
	Mahoning	Smith	29	7
		Beaver	12	8
			14	9
			23	10
No. 7	Columbiana	Center	1	11
			21	12
			30	13
			15	14a
			15	14b 3/
		Elk Run	18	15
			25	16
			27	17
			31	18
			2	19
			12	20
			9	21
			14	22
			17	23
		Middleton	1	24
		Wayne	1	25
			11	26
			36	27
	Mahoning	Green	18	28
Mahoning	Columbiana	Elk Run	15	29
			29	30
		Fairfield	24	31
		Middleton	2	32
			10	33
		Unity	35	34

3/ Physical and chemical analyses of spoils adjacent to high-wall described in table 14a.

Table 2.--Descriptions and chemical analyses ^{1/} of strata over the No. 1,

Sharon coal, Atwater Township, Portage County, Ohio

(Sample from high-wall located about 1/8 mile west and 1/4 mile south of the junction of U. S. Highway No. 224 with State Highway No. 225).

Description of strata (Top to bottom)	:Thickness: : of : strata	Acidity: : of : strata	:Available ^{2/} : :phosphorus	:Available ^{2/} : :potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray silty clay loam	1/2	6.0	Low	Low
Glacial till--sand to sandy clay, gray to yellow, mixed with igneous stones	12	5.6	High	Low
Mixture--in places a blue-gray, hard, silty shale; in other places a fragmental sandstone; lower part a massive sandstone	25	6.8	High	Medium
Shale--gray to black, clayey, very hard, slaty, almost massive	8	4.7	High	Low

^{1/} The technique used in the chemical analyses is described in the following publications:

R. H. Bray, Photometer Method for Determining Available Potassium in Soils. Dept. of Agronomy, Agr. Exp. Sta., University of Illinois, College of Agriculture, Mimeographed Circular No. AG 1275, Sept. 14, 1945.

Charles Y. Arnold, and Touby Kurtz, Photometer Method for Determining Available Phosphorus in Soils. Departments of Agronomy and Horticulture, Agr. Exp. Sta., University of Illinois, College of Agriculture, Mimeographed Circular No. AG 1306, June 1946.

^{2/} For soils, the readings "High," "Medium," and "Low" indicate the following quantities per acre:

	<u>Low</u>	<u>Medium</u>	<u>High</u>
	- - - -	<u>Pounds per acre</u>	- - - -
Phosphorus	Less than 53	54-75	More than 75
Potassium	Less than 100	100-150	More than 150

Table 3.--Descriptions and chemical analyses of strata over the No. 1,

Sharon coal, Deerfield Township, Portage County, Ohio

(Sample from high-wall located just east of State Highway No. 225, about 1/4 mile south of its junction with U. S. Highway No. 224).

Description of strata (Top to bottom)	: Thickness : of : strata	: Acidity : of : strata	: Available : phosphorus	: Available : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray silty clay	1/2	5.2	Low	Low
Glacial till--a heavy, gray to reddish-brown clay mixed with igneous rocks and sandstone	12	6.8	Medium	Low
Sandstone--gray, fragmental, thin-bedded	15	7.3	Medium	Low
Sandstone--gray, massive	8	5.8	Low	Low
Shale--dark gray to black, carbonaceous, mixed with roof coal	1	2.7	High	Low
Coal--No. 1, Sharon	-	-	-	-

Table 4.--Descriptions and chemical analyses of strata over the No. 5,

Lower Kittanning coal in Ohio

(Sample from Section 13, Middleton Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loam	1/2	3.8	Low	Low
Subsoil--gray loam	2	4.5	Low	Low
Glacial till--sandy with pebbles, reddish, ferruginous	4	5.3	Medium	Low
Shale--grayish-black, thin- bedded, with nodular ores and concretions. Lower half more thick- bedded	30	6.0	High	Low
Coal--No. 5, Lower Kittanning	-	-	-	-

Table 5.--Descriptions and chemical analyses of strata over the No. 5,

Lower Kittanning coal in Ohio

(Sample from Section 17, Salem Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam	1/2	4.7	High	Medium
Glacial till--sandy, mixed with granite boulders and pebbles	10	5.6	Medium	Low
Shale--gray, thin-bedded, rotten, and ferruginous; mixed with red kidney ores and some shale which is thin, black, slaty, and soft	12	4.3	High	Low
Coal--No. 5, Lower Kittanning	-	-	-	-

Table 6.--Descriptions and chemical analyses of strata over the No. 5,

Lower Kittanning coal in Ohio

(Sample from Section 12, Beaver Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available :	Available :
	: of : strata	: of : strata	: phosphorus	: potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loam	1/2	4.2	Low	Low
Glacial till--yellow-brown sandy clay mixed with pebbles	4	4.7	Low	Low
Soot streak--carbonaceous shale, possibly outcrop of No. 6 coal	3	5.0	Low	Low
Shale--gray, soft, thin-bedded, clayey, very toxic in spots	30	3.0	Low	Low
Shale--hard, thin-bedded, mottled orange, fossilif- erous, with concretions and red kidney ores	6	3.9	Medium	Low
Coal--No. 5, Lower Kittanning	-	-	-	-

Table 7.--Descriptions and chemical analyses of strata over the No. 6,

Middle Kittanning coal in Ohio

(Sample 1/ from Section 29, Smith Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata	: of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam	1	3.9	Low	Low
Sandstone--upper half of stratum thin-bedded, mixed with sand; lower half massive	16	3.9	High	Low
Shale--thin-bedded, gray, soft, silty, ferruginous; lower foot of stratum somewhat carbonaceous, rotten	5	3.0	Medium	Low

1/ Spoils adjacent to high-wall from which this sample was taken were classified as toxic, stony sands.

Table 8.--Descriptions and chemical analyses of strata over the No. 6,

Middle Kittanning coal in Ohio

(Sample 1/ from Section 12, Beaver Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata :	: of strata :		
	<u>Feet</u>	<u>pH</u>		
Soil--gray silt loam	1/4	4.8	Low	Low
Glacial till--mixture of sand and clay, partly calcare- ous, grayish-brown, mixed with igneous rocks and sandstone	10	7.1	Medium	Low
Sandstone--massive, gray to gray-brown	18	7.0	High	Low
Shale--dark gray, soft, rotten, thin-bedded, clayey, fer- ruginous, with red kidney ores	4	3.7	Medium	Low

1/ Spoil surfaces adjacent to high-wall from which this sample was taken were stony sands. Approximately 20 percent of area estimated to be toxic, 40 percent with pH from 4.0 to 6.9, and 40 percent with pH of 7.0 or above.

Table 9.--Descriptions and chemical analyses of strata over the No. 6,

Middle Kittanning coal in Ohio

(Sample 1/ from Section 14, Beaver Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata	: of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--gray silt loam	1/2	4.3	Medium	Low
Glacial till--sandy clay, mixed with igneous rocks	12	5.2	Medium	Low
Sandstone--gray to brown, massive, coarse	6	6.1	High	Medium
Shale--gray to black, carbo- naceous, thin-bedded, clayey, medium hardness	12	4.2	Medium	Low
Coal--No. 6 ("Rider vein")	1			
Shale--gray-black, clayey	3	5.5	Medium	Low
Coal--No. 6 (Main seam)	-	-	-	-

1/ Spoils adjacent to high-wall from which this sample was taken were classified as shaly sands of mixed acidity. Approximately 25 percent of the surface was estimated to be toxic, 25 percent with pH from 4.0 - 5.5, 25 percent with pH from 5.6 - 6.9, and 25 percent with pH from 7.0 to 7.9.

Table 10.—Descriptions and chemical analyses of strata over the No. 6,

Middle Kittanning coal in Ohio

(Sample 1/ from Section 23, Beaver Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata	: of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam, acidic	1/2	5.2	Medium	Low
Glacial till--sandy, mixed with sandstone and concretions	1	5.7	Low	Low
Sandstone--massive, acidic, in places changing to a thin- bedded, ferruginous sand- stone and shale	15	4.6	Low	Low
Shale--very soft, thin-bedded, silty, ferruginous	4+	2.5	Low	Low
Talus	12	-	-	-

1/ Spoils adjacent to high-wall from which this sample was taken were found to be extremely toxic and composed of a mixture of stony sand and stony clay.

Table 11.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 1, Center Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness : : of : : strata :	Acidity : : of : : strata :	: Available : : phosphorus :	: Available : : potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray silt loam, acidic	1/2	4.6	Medium	Low
Glacial till--sandy, mixed with granite and sand- stone pebbles	6	4.9	Low	Low
Sandstone--fragmental thin- bedded, mixed with sand, acidic	4	5.8	Medium	Low
Shale--gray, silty, hard	6	5.8	Medium	Low
Shale--blue-gray, hard, fragmental, calcareous	20	8.3	High	Low
Shale--blue-gray, carbonaceous, acidic	4	5.2	Low	Low

Table 12.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 21, Center Township, Columbiana County)

Description of strata (Top to bottom)	Thickness of strata	Acidity of strata	Available phosphorus	Available potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam, acidic	1/2	5.0	Low	Low
Glacial till--ranging from sandy clay to pure sand, yellow- brown, acidic	8	4.7	Low	Low
Sandstone--gray, massive, upper 1/3 fragmental, mixed with sand, lower 2/3 massive, with ferruginous streaks, acidic - tilted in places	20	6.2	Medium	Low
Shale--blue-gray, hard, silty, mottled red, ferruginous	6	4.8	Medium	Low

Table 13.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 30, Center Township, Columbiana County)

Description of strata (Top to bottom)	Thickness of strata	Acidity: of strata	Available phosphorus	Available potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam, acidic	1/2	5.6	Low	Low
Subsoil--sandy silty clay loam, gray-brown acidic with some glacial till	2	4.7	Low	Low
Sandstone--gray, thin-bedded, almost shaly; fragmental, mixed with glacial till	3	4.7	Medium	Low
Shale--thin-bedded, gray-brown, rather hard; silty, some of it sandy	15	5.3	Medium	Low
Shale--thin-bedded, carbonaceous, slaty, hard, bony, silty, blue-gray to black	6	6.5	High	Low

Table 14A.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 15, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness : : of : : strata	: Acidity : : of : : strata	: Available : : phosphorus	: Available : : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--Wooster loam, with glacial till	1/2	6.3	Medium	Low
Subsoil--brown sandy loam, with some shale and well-rounded stones (glacial)	1	5.2	Medium	Low
Outcrop--Mahoning coal	1	4.7	Low	Low
Clay--dark gray, carbonaceous, shaly	5	4.5	Low	Low
Sandstone--grayish-brown, massive	13	5.8	Medium	Low
Shale--grayish to brown, silty, thin-bedded, hard, mixed with fragmental sandstone	22	6.1	High	Low
Coal--No. 7, Upper Freeport	-	-	-	-

Table 14B.—Physical and chemical analyses of random samples of spoils
adjacent to high-wall described in Table 14A

Sample No.	Depth of sample, inches	Percent of "soil"	Mechanical analyses ^{1/} of "soil" fraction			Acidity	Available phosphorus	Available potassium
			Sand	Silt	Clay	pH		
1	0-6	31	-	-	-	3.6	Medium	Low
	6-12	31	-	-	-	3.7	Medium	Low
	12-18	35	-	-	-	3.5	High	Low
2	0-6	39	25.2	34.6	40.2	6.2	High	Low
	6-12	41	-	-	-	6.6	Medium	Low
	12-18	49	-	-	-	6.5	High	Low
3	0-6	18	40.8	29.2	30.0	6.4	High	Low
	6-12	19	-	-	-	6.9	Medium	Low
	12-18	24	-	-	-	7.3	High	Low
4	0-6	43	20.0	45.2	34.8	6.4	Medium	Low
	6-12	26	-	-	-	6.4	Medium	Low
	12-18	31	-	-	-	6.4	High	Low
5	0-6	41	-	-	-	5.6	High	Low
	6-12	43	-	-	-	5.2	High	Low
	12-18	48	-	-	-	5.1	High	Low

^{1/} Mechanical analyses by the Boyoucos Hydrometer Method

Table 15.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 18, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata :	: of strata :		
	<u>Feet</u>	<u>pH</u>		
Soil--silt loam, gray	1/2	5.0	Low	Low
Subsoil--glacial till, silt loam, acidic	2	5.5	Low	Low
Sandstone--shaly, fragmental, mixed with sand, thin- bedded, acidic	4	4.8	Medium	Low
Shale--gray, silty, thin-bedded	10	5.8	High	Low
Shale--blue-gray, hard, silty, becoming carbonaceous and silty in lower 1/6	12	6.4	Medium	Low

Table 16.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 25, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	Thickness : of : strata	Acidity : of : strata	Available : phosphorus	Available : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loam, acidic	1/2	4.3	Low	Low
Subsoil--glacial till, dark brown silty clay loam, acidic with fragments of sandstone	4	4.3	Low	Low
Glacial till--green sandy clay, acidic	8	5.3	Medium	Low
Sandstone--some brown, some gray, massive, thin- bedded in lower 2 feet, acidic	6	5.8	Medium	Low
Shale--gray, thin-bedded, silty, hard, somewhat slaty, ferruginous in spots, acidic	15	5.3	High	Low
Talus	3	-	-	-

Table 17.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 27, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	Thickness : of : strata	Acidity : of : strata	Available : phosphorus	Available : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown silt loam, acidic	1/2	4.7	Low	Low
Subsoil--glacial, silty clay loam, acidic	1	4.7	Low	Low
Shale--thick-bedded, mixed with considerable silty clay loam soil and considerable fragments of sandstone, gray, brown, acidic	12	5.1	Medium	Low
Sandstone--micaceous, gray-brown, massive, intermixed with thin-bedded sandstone and sandy, soapy shale, acidic	12	5.1	High	Low
Shale--gray, thin-bedded, micaceous, sandy in upper half, changing downward into a dark, thin-bedded gray, ferruginous silty shale, hard	8	4.0	High	Low

Table 18.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 31, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness : : of : : strata :	Acidity : : of : : strata :	: Available : : phosphorus :	: Available : : potassium :
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown, loam, acidic	1/2	4.2	Medium	Low
Subsoil--brown sandy clay loam, acidic	1	4.8	Medium	Low
Sandstone--fragmental, mixed with considerable sand	6	4.8	Low	Low
Sandstone--thin-bedded, fragmental, slightly ferruginous	6	5.0	Low	Low
Sandstone--gray-brown, massive	8	4.4	High	Low
Shale--thin-bedded, gray, hard, acidic	5	4.8	High	Low
Shale--very thin, platy, blue- gray to black, carbona- ceous, slaty, silty, acidic	6	5.0	High	Low

Table 19.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 2, Franklin Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam, acidic	1/2	4.8	Low	Low
Subsoil--yellow-brown clay loam, acidic	2	4.8	Low	Low
Shale--gray, sandy, acidic, mixed with soil	10	5.0	Medium	Low
Shale--gray, silty, rather hard, ferruginous	-	5.7	Low	Low
Shale--blue-gray and black, hard, bony, slaty; carbonaceous in lower 1/2	4	6.0	High	Low

Table 20.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 12, Hanover Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray sandy loam, acidic	1/2	5.5	Medium	Low
Subsoil--loamy sand, acidic, red-brown	2	4.8	Medium	Low
Sandstone--thin-bedded, frag- mental, mixed with sandy material	25	5.4	Low	Low
Shale--blue-gray, hard, bony, silty, but not slaty	4	6.7	High	Low

Table 21.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 9, Madison Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	: of : strata	: of : strata	: phosphorus	: potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loamy sand, acidic	1/2	4.2	Low	Low
Sand--stony sand, reddish- brown, acidic	1 1/2	4.8	Low	Low
Sand--red-brown, mixed with fragmental sandstone, acidic	8	5.0	Low	Low
Sandstone--brown, massive	16	4.6	Medium	Low
Shale--gray-black, thin-bedded, soft, silty, acidic, lower 1/3 changing to sandy shale, and some of it carbonaceous	5	5.5	High	Low

Table 22.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 14, Madison Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--sandy loam, stony, gray-brown, acidic	1/2	4.9	Low	Low
Subsoil--gray-brown sand, mixed with considerable thin-bedded, fragmental sandstone	5	5.5	Low	Low
Sandstone--gray to brown, thin-bedded, fragmental, lower portion somewhat massive	20	5.7	Medium	Low
Shale--thin-bedded, acidic, silty; in some spots hard and slaty; in other spots ferruginous, soft and rotten with some concretions	6	3.9	High	Low

Table 23.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 17, Madison Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness : of : strata	: Acidity : of : strata	: Available : phosphorus	: Available : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown loam, acidic	1/2	4.8	Low	Low
Subsoil--yellow-brown sandy loam, acidic	1 1/2	4.8	Low	Low
Sand--brown, mixed with sandstone pebbles, acidic	4	4.7	Low	Low
Sandstone--gray-brown, acidic, thin-bedded, fragmental	15	6.8	High	Low
Sandstone--thin-bedded, light gray, somewhat massive, very hard. Upper portion with iron streaks	6	6.9	High	Low
Shale--dark gray to black, thin-bedded, acidic, rotten, slightly ferruginous	6	3.6	Medium	Low

Table 24.--Descriptions and chemical analyses of strata over the No. 7,Upper Freeport coal in Ohio

(Sample from Section 1, Middleton Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available :	Available :
	: of : strata	: of : strata	: phosphorus	: potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown silt loam, acidic	1	5.1	Low	Low
Glacial till--acidic silt loam, with glacial rocks and some shale, gray- brown	6	5.4	Low	Low
Shale--sandy, thin-bedded, gray, fragmental, acidic	10	6.8	Medium	Low
Sandstone--gray, massive	6	6.5	Medium	Low
Shale--thick-bedded, gray, sandy, acidic	6	5.5	Medium	Medium
Shale--carbonaceous, bony, (roof coal) somewhat slaty	4	4.9	Medium	Low

Table 25.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 1, Wayne Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam, acidic	1/2	4.9	Low	Low
Subsoil--gray-brown, acidic, spotty sand and clay, mixed with fragmental sandstone, lower 1/3 mostly fragmental sandstone	6	5.3	Low	Low
Sandstone--gray, thin-bedded, somewhat massive in lower half, acidic	6	5.3	Low	Low
Shale--gray in upper 1/2, hard, silty, thin-bedded; lower 1/2 dark gray to black, mottled red, hard, slaty, silty	12	6.8	Medium	Low

Table 26.--Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 11, Wayne Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available :	Available :
	: of : strata	: of : strata	: phosphorus	: potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray loam, acidic	1/2	5.1	Low	Low
Silt loam--chocolate brown, blocky structure with small sandstone fragments in lower foot	3 - 5	4.8	Low	Low
Sand--red-brown, fine, acidic	5	5.1	Low	Low
Shale--upper 1/2 gray, thin- bedded, soft; lower 1/2 blue-gray, carbonaceous, hard, slaty, silty and ferruginous	12	5.7	High	Low

Table 27.—Descriptions and chemical analyses of strata over the No. 7,

Upper Freeport coal in Ohio

(Sample from Section 36, West Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available phosphorus	Available potassium
	of strata	of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--sandy loam, gray, acidic	1/3	4.4	Medium	Low
Sand--mixed with fragments of sandstone	2	4.7	Low	Low
Sandstone--fragmental, mixed with sandy soil and some silty shales	10	5.4	Low	Low
Shale--silty, gray, ferruginous, fragmental; not so hard as shale in this stratum farther east in county. Lower 1/3 blue-gray, hard, silty but not slaty	12	4.9	Medium	Low
Coal--No. 7, Upper Freeport	-	-	-	-

Table 28.--Descriptions and chemical analyses of strata over the No. 7,Upper Freeport coal in Ohio

(Sample from Section 18, Green Township, Mahoning County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata :	: of strata :		
	<u>Feet</u>	<u>pH</u>		
Soil--brown loamy sand, acidic	1	4.8	Low	Low
Glacial till--yellow, sandy clay loam, acidic, mixed with considerable large igneous rocks, sandstone and con- cretions	8	6.1	Medium	Low
Sandstone--gray to brown, massive, acidic, gray stones at lower end slightly calcareous	12	6.5	High	Low
Shale--gray, silty, calcareous in most places, hard, with occasional boulders of bastard limestone	18	6.4	Medium	Low
Shale--blue-gray to black, carbonaceous, hard, slaty, partly calcareous	8	6.8	High	Low

Table 29.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 15, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	Thickness of strata	Acidity of strata	Available phosphorus	Available potassium
	<u>Feet</u>	<u>pH</u>		
Soil--dark gray-brown silt loam, acidic	1/2	4.9	Low	Low
Subsoil--gray-brown silt loam, acidic, with some glacial pebbles and sandstone	1	4.8	Medium	Low
Shale--almost sandstone, frag- mental, brown acidic, thin-bedded, with sandy material	6	5.3	Medium	Low
Shale--gray-green, hard, thin- bedded, silty, acidic	12	5.3	Low	Low
Shale--blue-gray, slightly carbonaceous, hard, silty, slightly slaty, acidic	6	6.3	High	Low
Shale--blue-black roof coal, slaty, carbonaceous, hard, bony	4	7.1	High	Low

Table 30.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 29, Elk Run Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata	: of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--gray-brown silty clay loam, acidic	1/2	4.9	Medium	Low
Subsoil--reddish-brown silty clay loam, acidic, mixed with fragments of sandstone	3	5.0	Low	Low
Sandstone--gray-brown, thin- bedded, micaceous, frag- mental	12	4.8	Medium	Low
Shale--grayish to black, thin- bedded, hard, slaty, acidic, silty	18	4.3	Medium	Low

Table 31.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 24, Fairfield Township, Columbiana County)

Description of strata (Top to bottom)	Thickness of strata	Acidity of strata	Available phosphorus	Available potassium
	<u>Feet</u>	<u>pH</u>		
Soil--gray silt loam, acidic	1/2	4.7	Low	Low
Glacial till--yellow-brown silty clay loam, acidic, with glacial rocks, some of which are slightly calcareous	12	4.7	Low	Low
Shale--gray to greenish-gray, somewhat sandy but chiefly silty, acidic, thin-bedded, hard	4	6.7	Medium	Low
Shale--gray-black, carbonaceous, thin-bedded	8	7.4	High	Low
Shale--thick-bedded, silty but somewhat sandy, slightly calcareous, hard, massive	4	7.6	High	Low
Shale--gray-black, carbonaceous, slaty	2	7.7	Medium	Low

Table 32.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 2, Middleton Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness :	Acidity :	Available phosphorus	Available potassium
	: of strata	: of strata		
	<u>Feet</u>	<u>pH</u>		
Soil--grayish-brown acidic loam	1/2	4.9	Low	Low
Glacial till--composed mainly of greasy shale, thin-bedded, acidic; considerable sandy loam material, and occas- ional pieces of massive thick-bedded shale	10	5.2	Low	Low
Shale--gray, acidic, hard, thin- bedded; lower foot somewhat carbonaceous	20	5.2	High	Low
Coal--Mahoning	-	-	-	-

Table 33.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 10, Middleton Township, Columbiana County)

Description of strata (Top to bottom)	Thickness	Acidity	Available	Available
	of strata	of strata	phosphorus	potassium
	<u>Feet</u>	<u>pH</u>		
Soil--a sandy loam, gray-brown, acidic	1/2	4.8	Medium	Low
Subsoil--glacial till, a loam, gray-brown, acidic, with shale and glacial pebbles	3	5.1	Low	Low
Shale--grayish, thick-bedded, acidic, somewhat "blocky" in structure, upper 2 feet rather fragmental. A silty, hard, shale	20	5.5	Medium	Low
Shale--grayish-black, thin-bedded, hard	6	6.1	High	Low
Shale--carbonaceous roof coal, acidic	1	3.1	Low	Low

Table 34.--Descriptions and chemical analyses of strata over the Mahoning
coal in Ohio

(Sample from Section 35, Unity Township, Columbiana County)

Description of strata (Top to bottom)	: Thickness : of : strata	: Acidity : of : strata	: Available : phosphorus	: Available : potassium
	<u>Feet</u>	<u>pH</u>		
Soil--sandy loam, gray-brown, acidic	1/2	5.5	Low	Low
Glacial till--sandy loam, yellowish-brown, acidic	8	4.7	Low	Low
Sandstone--gray, thin-bedded, fragmental; some sand- stone calcareous	6	5.0	Low	Low
Shale--gray, acidic, thin- bedded, silty. Somewhat carbonaceous in lower 4 ft.	25	4.7	Medium	Low

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